State-of-the-Art Practices in Stream Restoration

Development in Chattanooga: The Stormwater Perspective

April, 2003

Fuller Mossbarger Scott & May ENGINEERS

RIVERMorph Stream Restoration Software

Fluvial Geomorphology

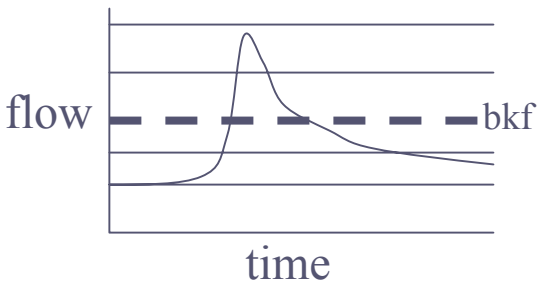
Branch of Science concerned with influence of Rivers and Streams on the formation of the Earth's surface

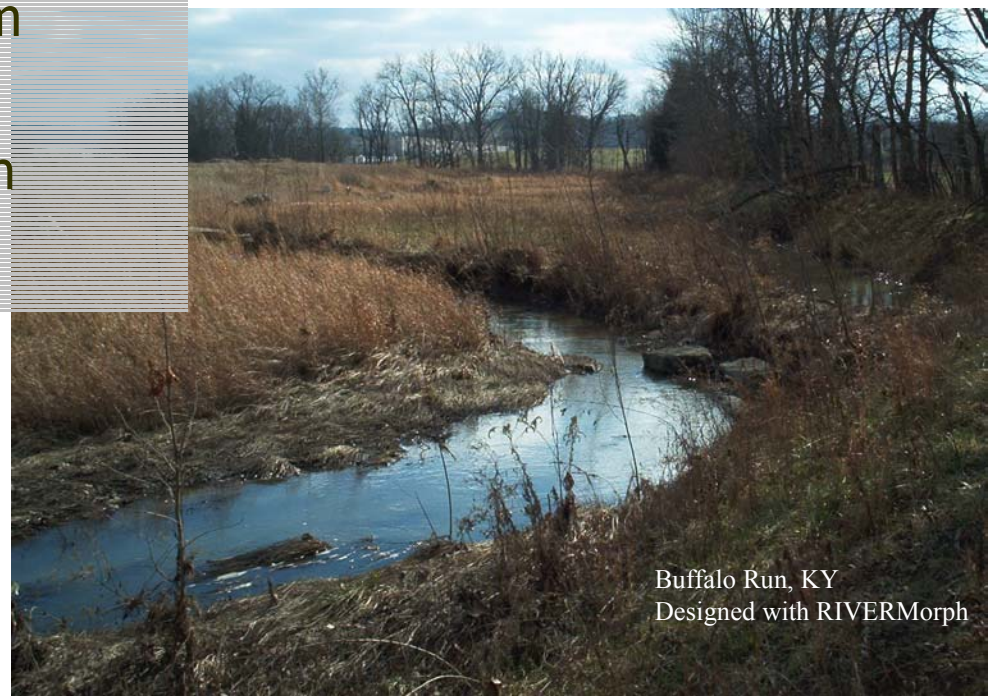
Governing Processes:

- Erosion
- Sediment Transport
- Deposition

Bankfull Discharge

- Controls Average, Long-Term Channel Form
- Corresponds to the Discharge that Channel Maintenance is Most Effective over the Long-Term
- Low Recurrence Interval
- Lower Recurrence Interval in Urban Watersheds




Buffalo Run, KY
Designed with RIVERMorph

Bankfull Indicators

- Flat, Depositional Surface Adjacent to Active Channel
- Height of Depositional Features (Point Bars)
- Change in Vegetation
- Slope or Topographic Breaks or Changes Along the Bank
- Change in Particle Size of Bed Materials

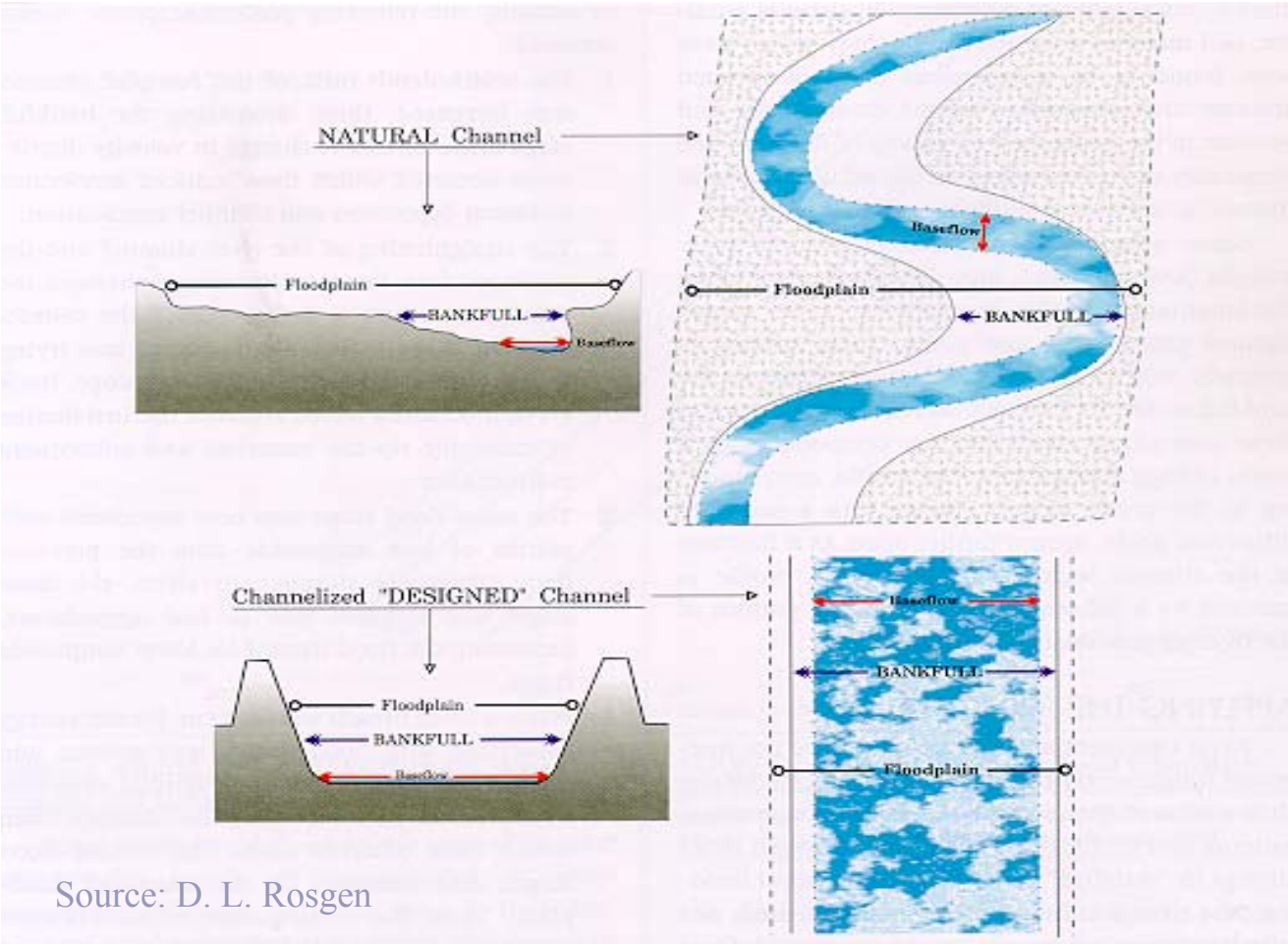
Entrenchment Ratio (ER)

The Vertical Containment of the Stream or the Degree of Incision in the Valley Floor

$$\text{Entrenchment Ratio} = \frac{\text{Width of Floodprone Area}}{\text{Width of Bankfull Channel}}$$

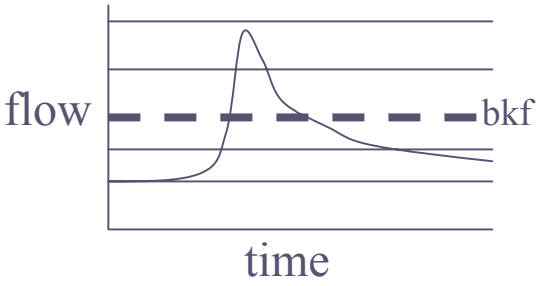
- Entrenched (Ratio < 1.4)
- Moderately Entrenched (1.4 - 2.2)
- Slightly Entrenched (Ratio > 2.2)

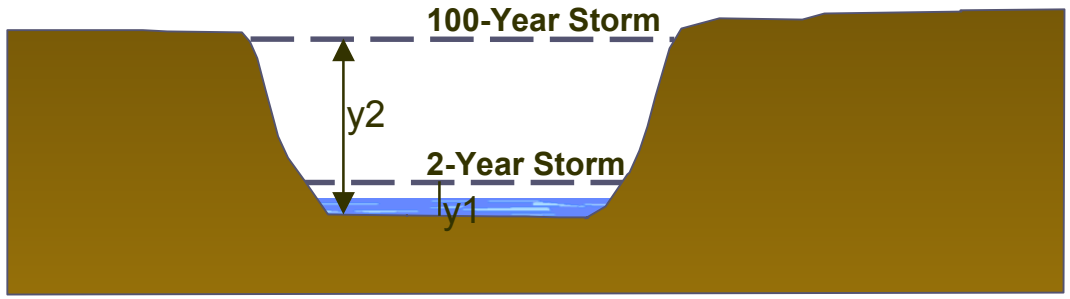
Natural vs. Man-Made Channels



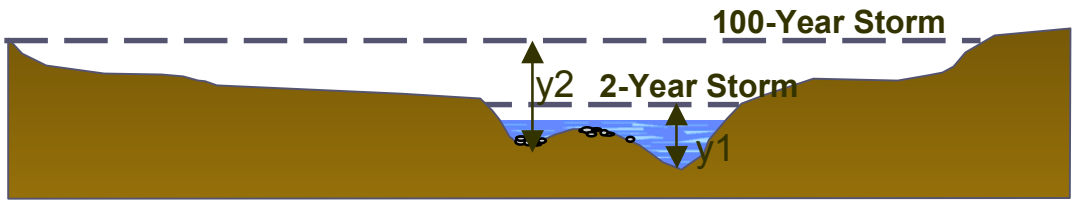
Source: D. L. Rosgen

Shear Stress

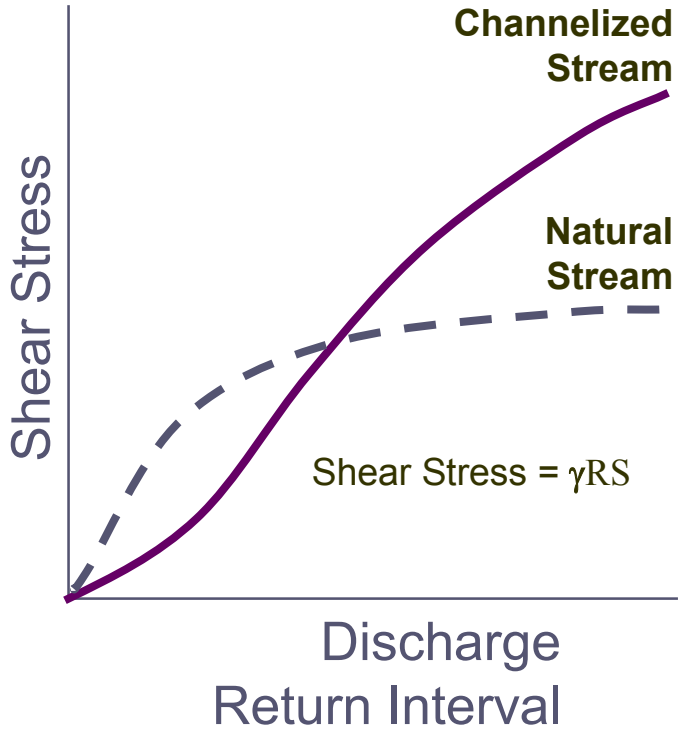




Channelized Stream



Natural Stream



Differences

CONCEPT	TRADITIONAL	GEOMORPHOLOGY
Time	Short-term	Long-term
Model	Theoretical	Field Measurement
Water	Clear	Sediment Laden
Spatial Scale	Reach	Watershed
Boundary	Rigid	Mobile
Maintenance	High	Sustainable
Design Flow	100 yr.	Bankfull Flow
Factor of Safety	Conservative	Balance of Forces

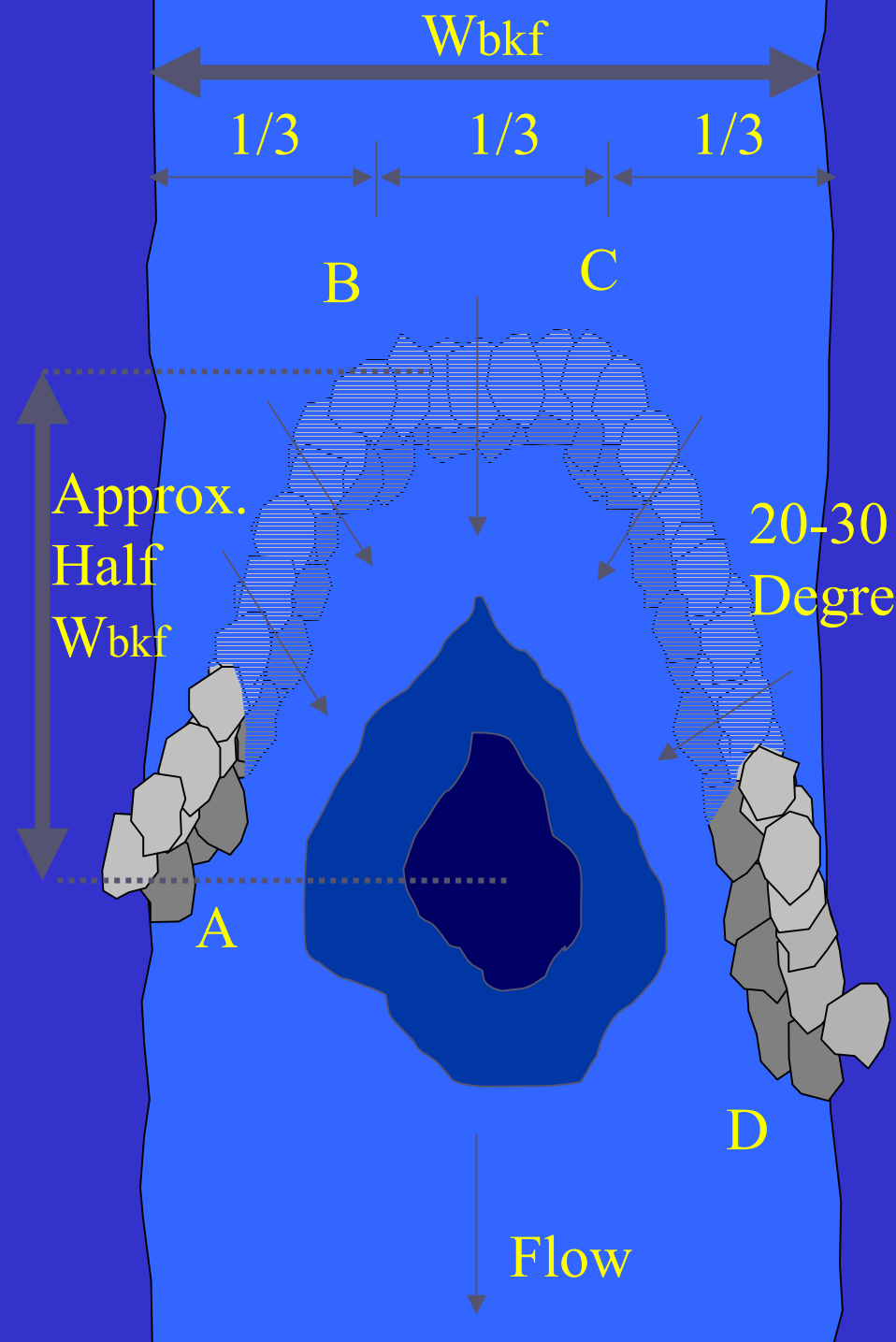
Natural Channel Design

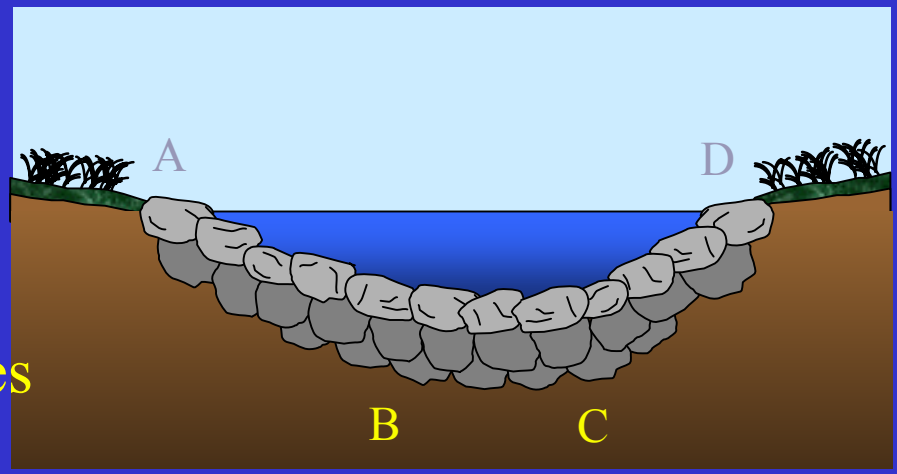
Process by which new or re-constructed stream channels and their associated flood plain riparian systems are designed to be naturally functional, stable, healthy, productive and sustainable.

Soil Bioengineering

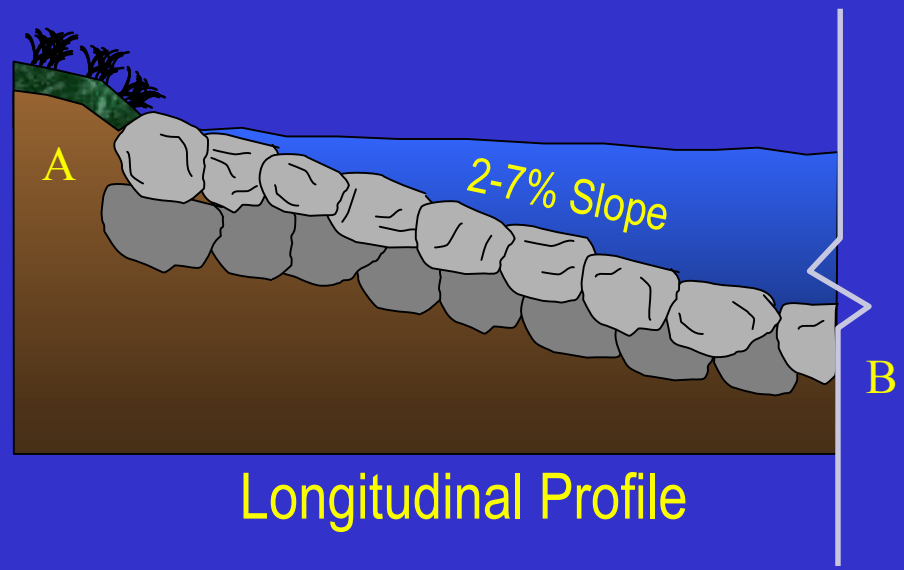
The Use of Living and Non-Living Materials to Provide Soil Reinforcement and Prevent Erosion

Cross-Vane





Cross Section View

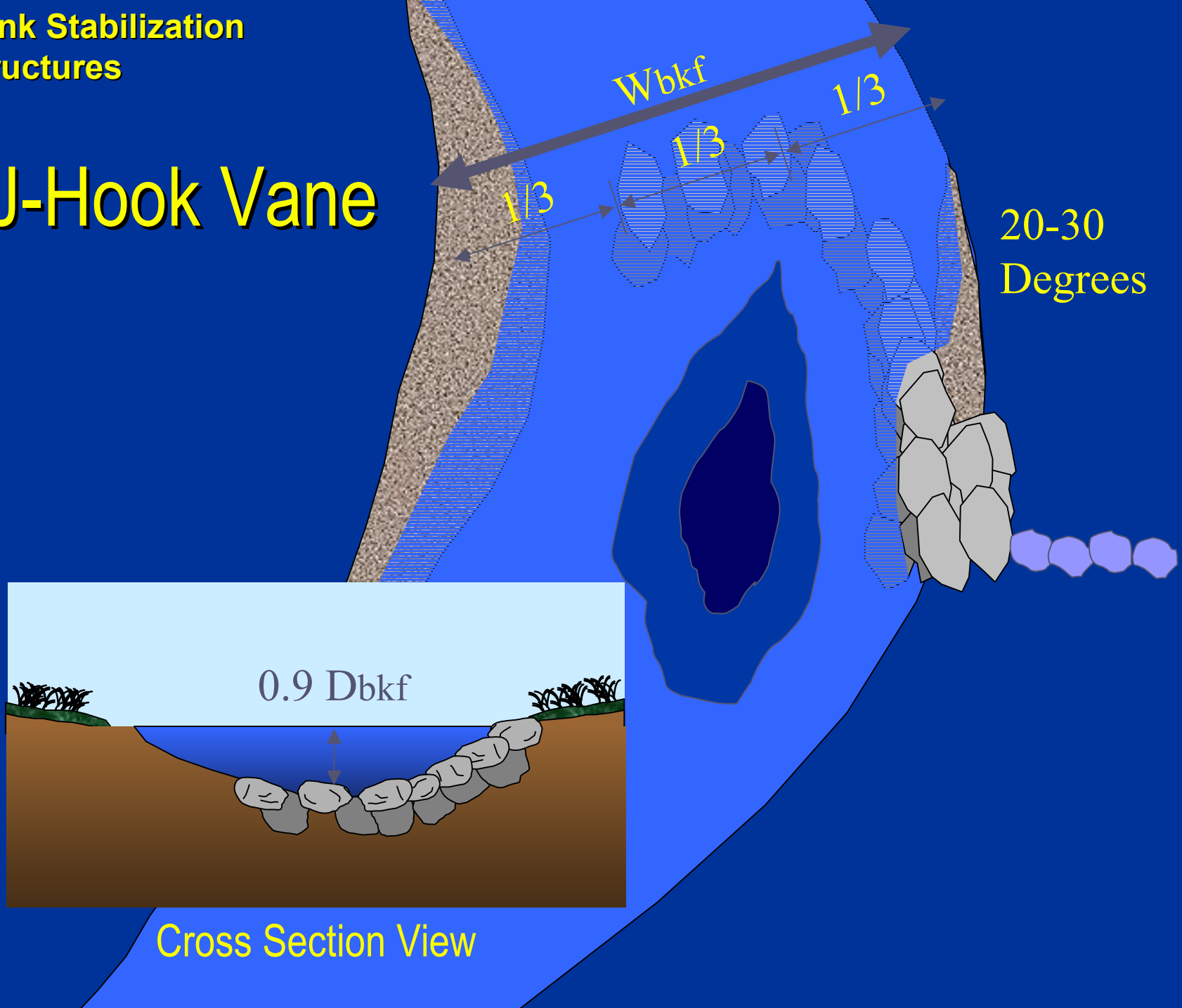


Longitudinal Profile

Rio Blanco

Bank Stabilization Structures

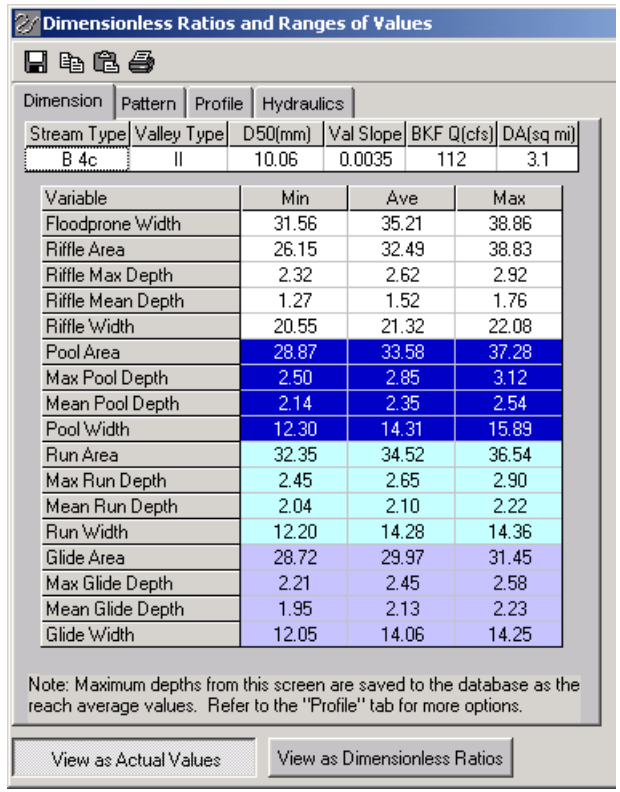
J-Hook Vane



Rio Blanco

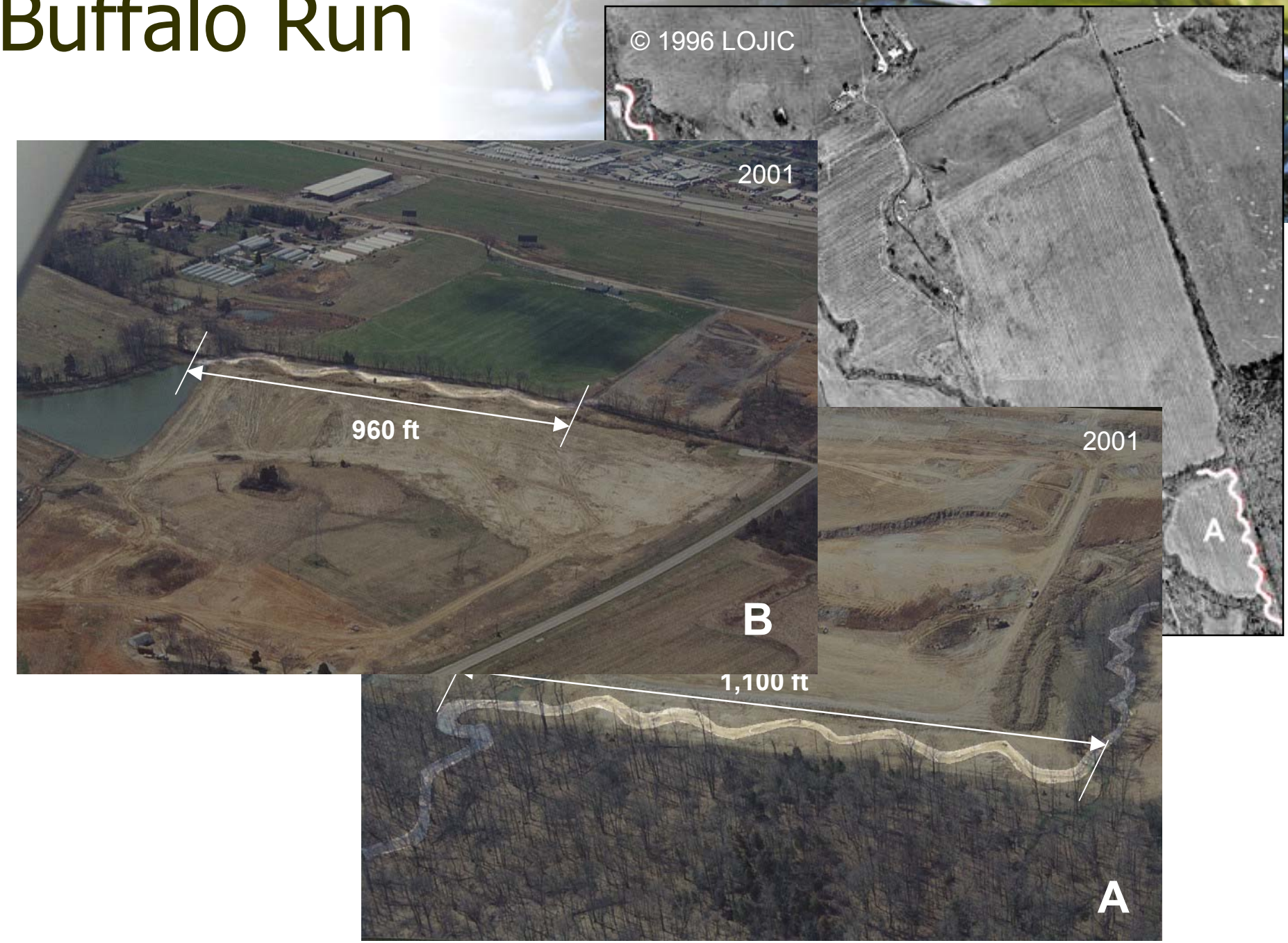
Reference Reach Approach

- Stable Reference Stream in Same Hydro-physiographical Region
- Streams Exist in Dynamic State of Equilibrium
- Requires a Number of Geomorphic Measurements - Range of Dimensionless Ratios
- Applies to Streams where Upper Ranges of Depositional Particles Begin to Mobilize at Bankfull
- In Sand Bed Streams Additional Analytical Analyses is Necessary

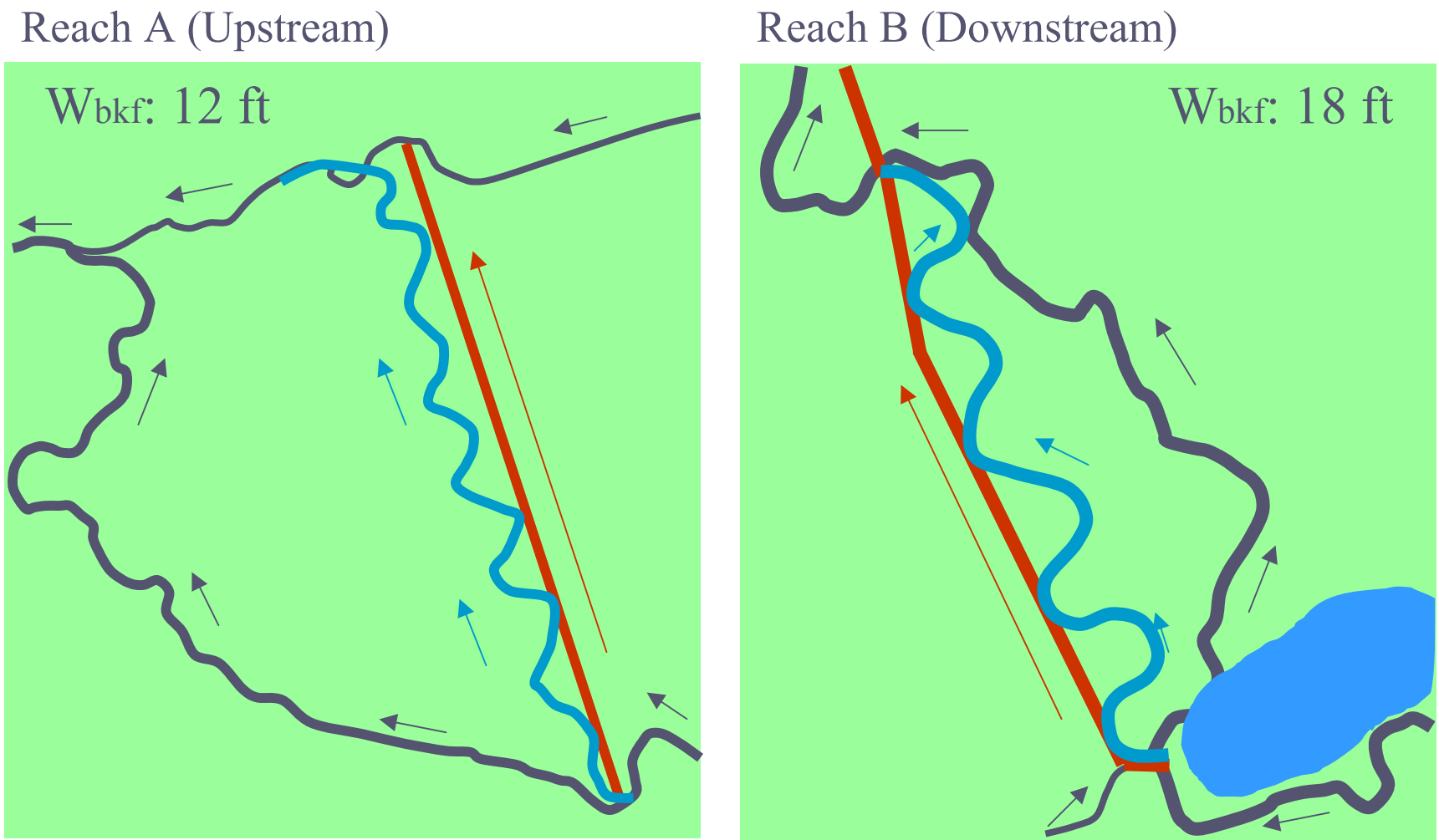


Buffalo Run Stream Restoration

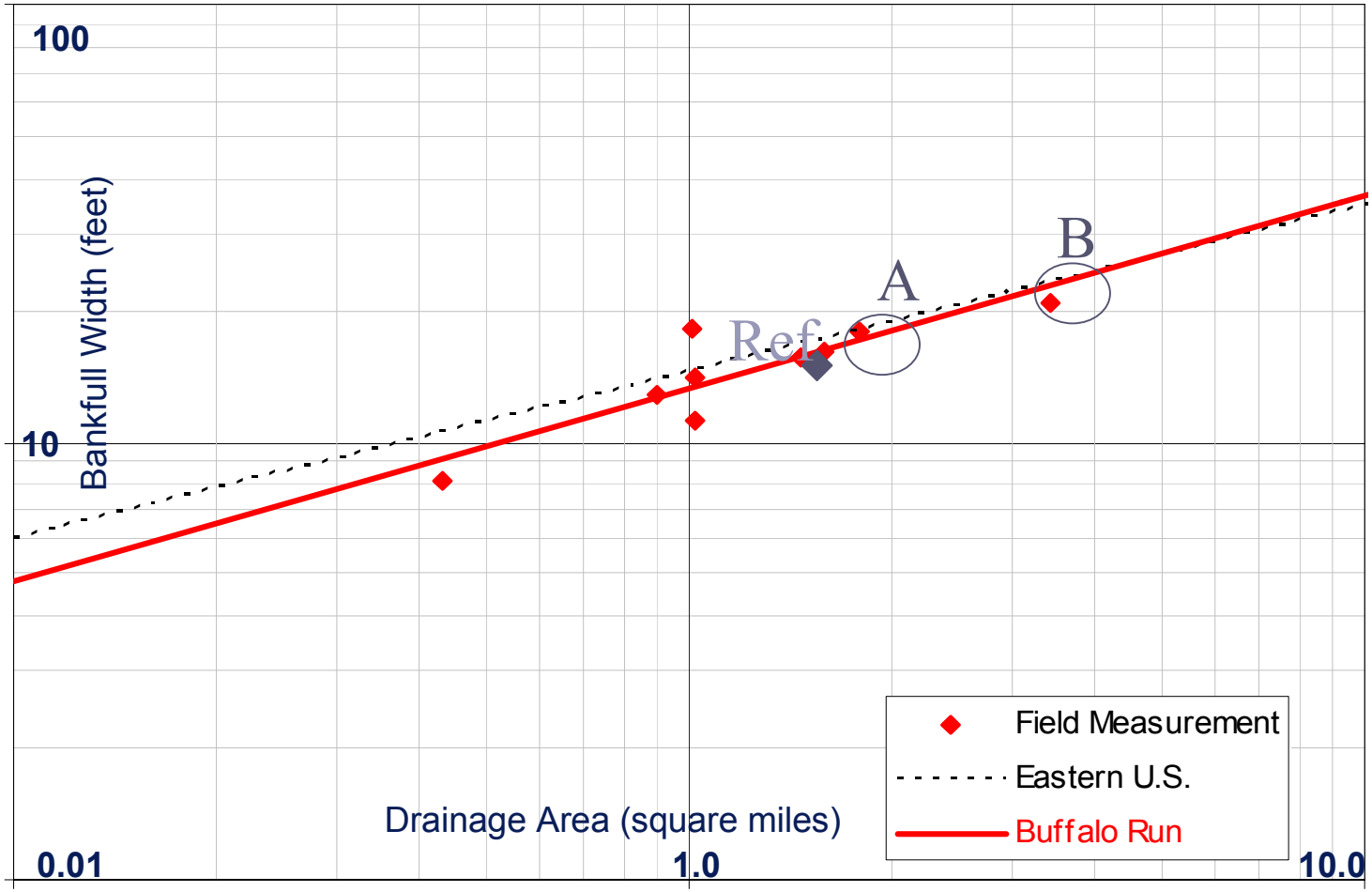
Buffalo Run



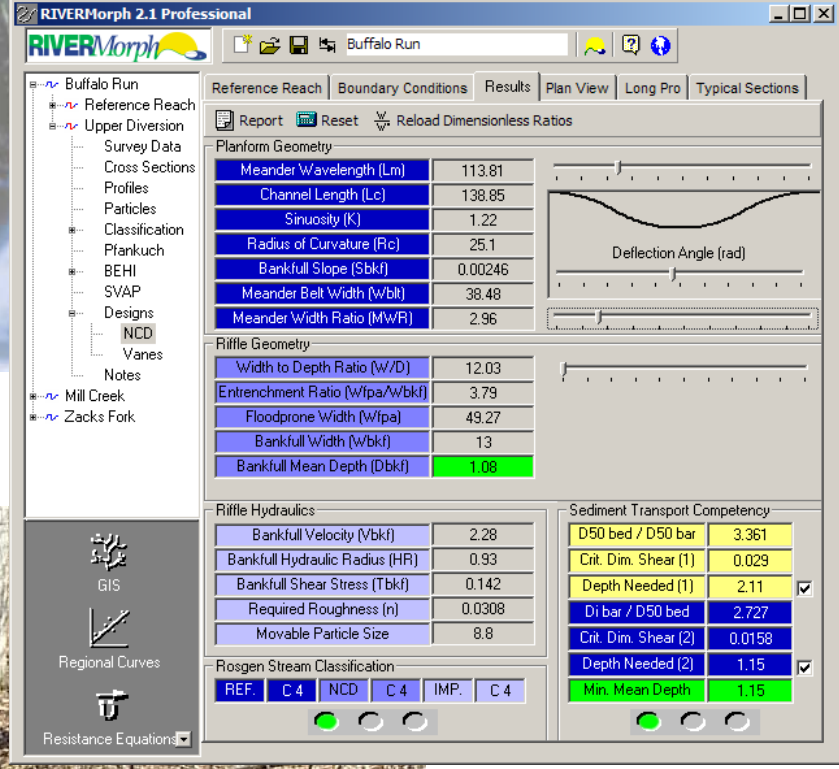
Natural Channel Designs

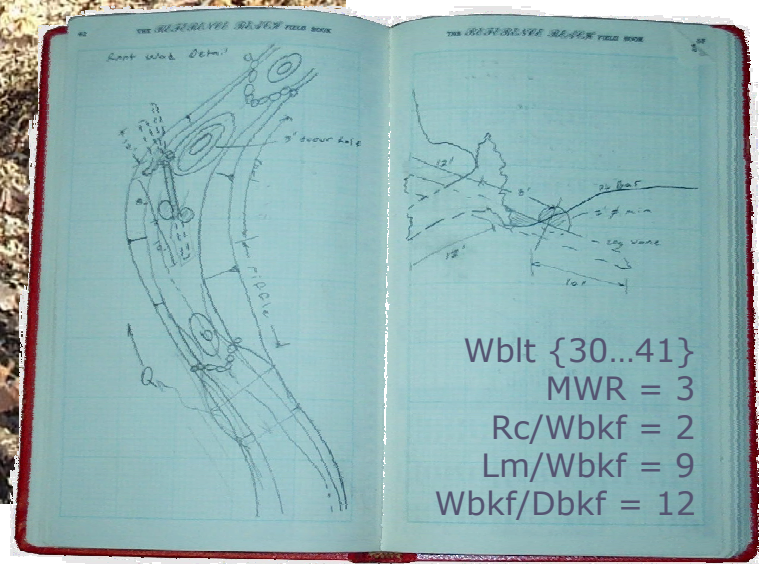


Design Processes
Step 1: Watershed Analysis



Design Process
Reference Reach





Boulder Structures

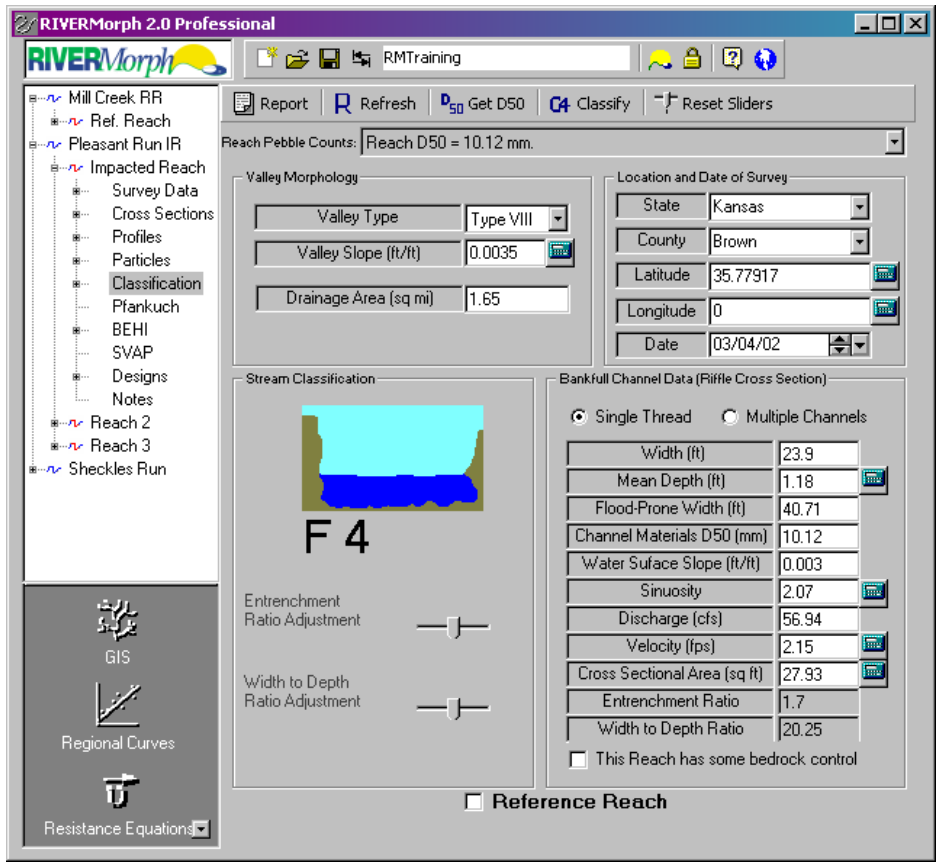
3.6 fps
11.4 fps
2.2 fps

Buffalo Run: Reach A
Natural Channel Diversion
C4 Stream Type

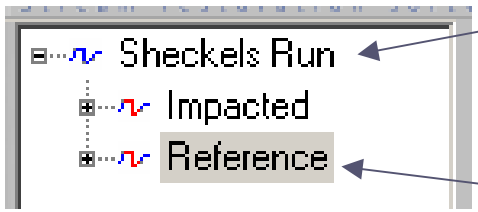
Buffalo Run: Reach B
Restoration
C6 Stream Type

Software Overview

- Software Features an Intuitive Graphical User Interface
- All Data Stored in a Database
- Measurements/Processing of Data is Graphically Oriented
- Greatly Simplifies Processing of Geomorphic Data

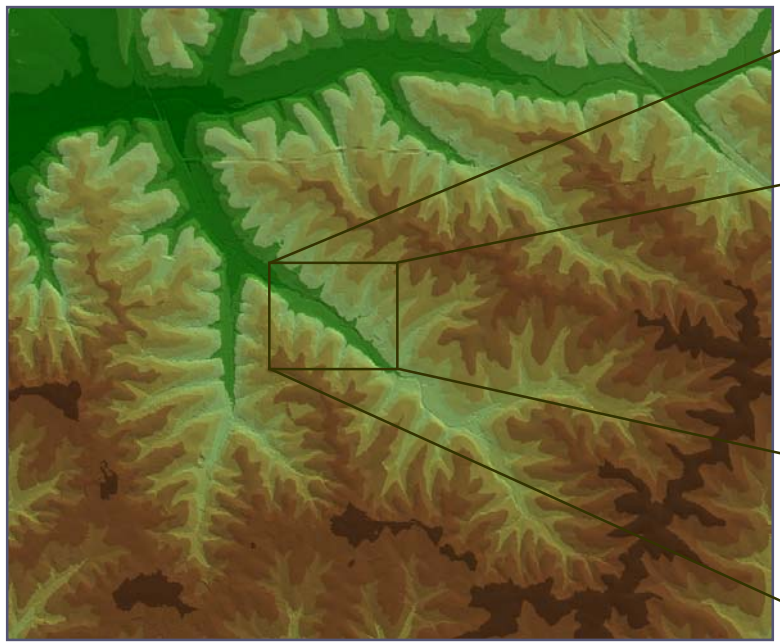


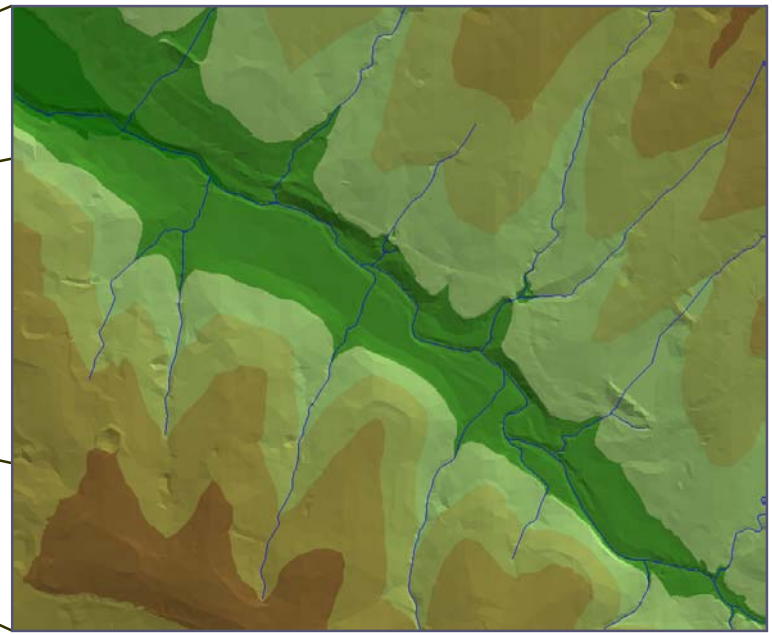
Rivers and Reaches



River

Reach





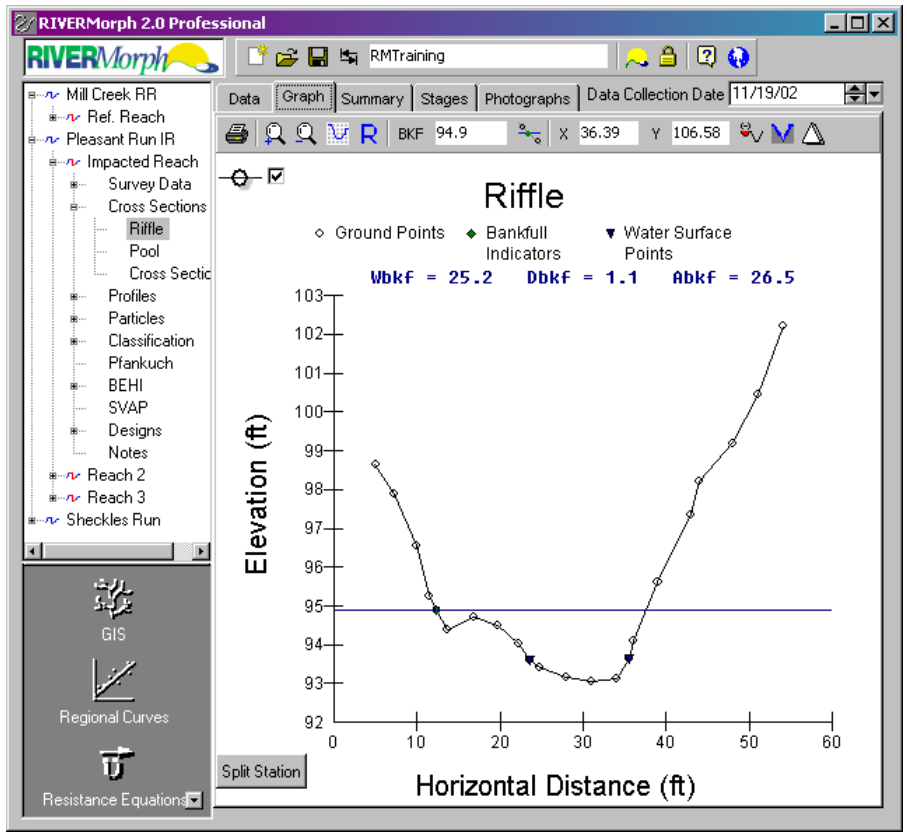
River Scale

Reach Scale – (20 to 30) x W_{bkf}

RIVERMorph Components

CHANNEL MEASUREMENT

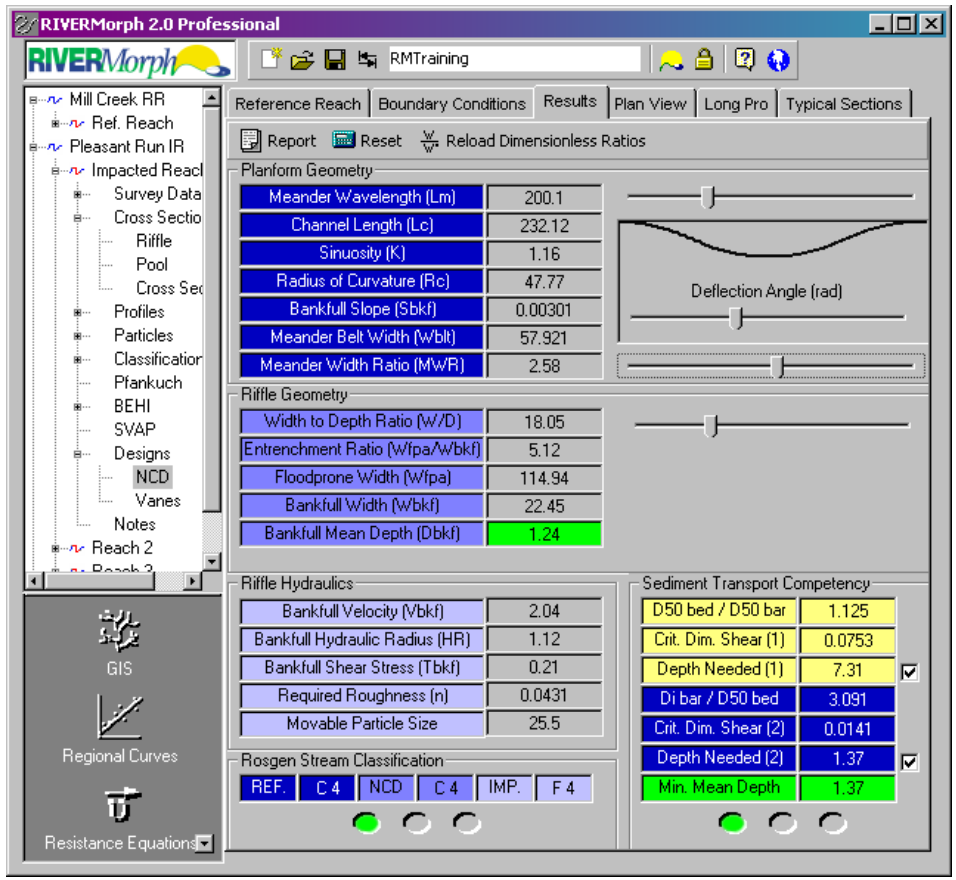
- Survey Data (Differential & Total Station)
- Cross Sections
- Longitudinal Profile
- Particle Size Analyses (Pebble Count & Sieve Analysis)
- Stream Classification



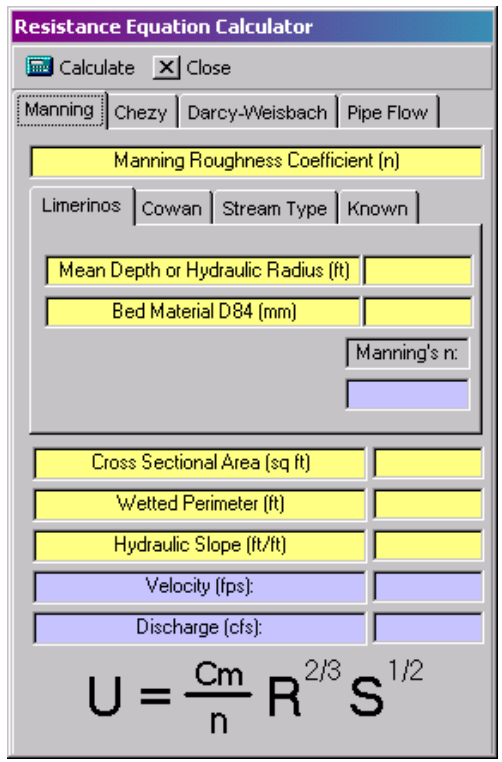
RIVERMorph Components

ANALYSES & DESIGN

- Pfankuch Channel Stability
- NRCS Stream Visual Assessment Protocol
- Natural Channel Design Using the Reference Reach Approach
- Vane Structures



RIVERMorph Components

CALCULATORS & TOOLS

- GIS
- Regional Curves
- Resistance Equations
- Regime Equations
- TR-55 Peak Flow
- Gage Analysis